SPECIFICATION

TITLE OF THE INVENTION

APPARATUS FOR AND METHOD OF CONTROLLING SEED COTTON DRYING IN A COTTON GIN

BACKGROUND OF THE INVENTION

(1) 1. Field of the Invention: The present invention relates, in general, to the initial drying of seed cotton in a cotton gin, and in particular, to an apparatus for and a method of controlling the initial drying of seed cotton in a cotton gin.

(2) 2. Background Art: A modern cotton gin includes several coacting subsystems or stages. Seed cotton (i.e., raw cotton from the cotton field) usually arrives at the cotton gin loosely packed in large trailers or tightly compressed in large modules. The seed cotton is delivered to some type of seed cotton feeder that might include a module feeder to break-up and disperse tightly packed cotton module into a loose conveyable form, and/or a conveyor means such as a screw, belt or suction pipe to convey the loose conveyable seed cotton to initial stage of the ginning process, typically a seed cotton initial dryer stage using heated air to reduce the moisture content of the seed cotton. Such a seed cotton initial dryer stage normally include gas or oil-fired heaters for heating the air used to convey the seed cotton from the seed cotton feeder, to reduce the moisture content of the seed cotton to some desired moisture level for efficient cleaning and ginning (this moisture level is normally set by the gin management). After the seed cotton dryer stage, the seed cotton commonly passes through a rough cleaning stage to remove leaves, small trash, sticks, etc., therefrom. The partially processed seed cotton is

then transferred to one or more gin stands for "ginning," i.e., for separation of the cotton seed and fiber. A typical cotton gin may have three or more gin stands. After ginning, the cotton fiber is typically referred to as "lint cotton" or just "lint." The lint may then pass through a lint cleaning stage to remove any small trash or dirt remaining in the lint, and then be carried through a lint flue or the like to a battery condenser for being formed into a continuous batt and discharged onto a lint slide. The batt is conveyed down the lint slide to a bale press where the batt is compressed and formed into one or more cotton bales. Each bale may then be tied with bailing wire and wrapped with plastic, etc., before being stored or transferred to a warehouse, textile mill, etc.

(3) Nothing in the known prior art, either singly or in combination, discloses or suggests the present invention.

BRIEF SUMMARY OF THE INVENTION

(4) The present invention incudes an apparatus for and a method of controlling the initial seed cotton dryer stage of seed cotton in a cotton gin. The concept of the present invention is to precisely control the drying of seed cotton in the initial seed cotton dryer stage of a cotton gin in order to provide high quality ginned cotton at a lower cost by removing only the precise amount of moisture from the seed cotton to arrive at the desired moisture content of the seed cotton. The basic concept is to determine the amount of energy needed to remove a certain amount (pounds) of water from seed cotton entering a cotton gin.

(5) The apparatus of the present invention includes means for measuring the rate of seed cotton entering a seed cotton dryer stage; means for measuring the moisture

content of the seed cotton entering the seed cotton dryer stage; and means for causing the seed cotton dryer stage to remove an amount of moisture from the seed cotton based on the desired moisture content of the seed cotton after leaving the seed cotton dryer stage, the moisture content of the seed cotton entering the seed cotton dryer stage, and the rate of seed cotton entering the seed cotton dryer stage.

(6) The method of the present invention includes the steps of measuring the rate of seed cotton entering a seed cotton dryer stage; measuring the moisture content of the seed cotton entering the seed cotton dryer stage; and controlling the seed cotton dryer stage to cause the seed cotton dryer stage to remove an amount of moisture from the seed cotton based on the desired moisture content of the seed cotton leaving the seed cotton dryer stage, the moisture content of the seed cotton entering the seed cotton dryer stage, and the rate of seed cotton entering the seed cotton dryer stage.

(7) One object of the present invention is to provide an accurate apparatus and method for removing a precise amount of moisture from seed cotton in the seed cotton drying stage of a cotton gin.

(8) Another object of the present invention is to provide such an apparatus and method that reduces the energy used to remove moisture from seed cotton in the seed cotton drying stage of a cotton gin to a minimum.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

(9) Fig. 1 is a block diagram of the apparatus of the present invention, shown in combination with various components of a cotton gin.

(10) Fig. 2 is a more detailed diagram of portions of Fig. 1.

(11) Fig. 3 is a somewhat schematic view of the apparatus of the present invention,

shown in combination with various portions of a cotton gin.

(12) Fig. 4 is a diagram showing the arrangement of Figs. 4A-4I.

(13) Figs. 4A-4I, taken together and arranged as shown in Fig. 4, disclose a preferred program for controlling the programmable logic controller of the apparatus of the present invention based on, for example, a three gin stand system.

DETAILED DESCRIPTION OF THE INVENTION

(14) A preferred embodiment of the apparatus of the present invention is shown in the drawings and identified by the numeral **11**. The apparatus **11** of the present invention is designed to control the removal of moisture from seed cotton, as indicated diagrammatically by arrows **13** in Figs. 1 and 3, passing through a seed cotton dryer stage **15** to one or more gin sets or stands **17** in a typical cotton gin.

(15) The apparatus **11** includes rate measuring means **19** for measuring the rate of seed cotton **13** entering the seed cotton dryer stage **15**; moisture content measuring means **21** for measuring the moisture content of the seed cotton **13** entering the seed cotton dryer stage **15**; and seed cotton dryer control means **23** for controlling the seed cotton dryer stage **15** in a manner to remove a precise amount of moisture from the seed cotton **13** based on the desired moisture content of the seed cotton **13** leaving the seed cotton dryer stage **15**, the moisture content of the seed cotton **13** entering the seed cotton dryer stage **15**, and the rate of seed cotton **13** entering the seed cotton dryer stage **15**. The apparatus **11** preferably includes a programmable logic controller (PLC) **25** for monitoring and controlling the means **19**, **21**, **23**, etc.

(16) The actual construction and operation of the cotton gin may vary as will be apparent to those skilled in the art. Thus, for example, the cotton gin typically includes

some type of seed cotton unloading system or feeder **27**, such as a large suction pipe or module feed system, for unloading and breaking up seed cotton **13** (i.e., raw cotton from the cotton field) that usually arrives at the cotton gin in large trailers or modules. and conveying the seed cotton **13** from the trailers or modules to subsequent stages of the ginning process. The gin typically uses an air stream generated by an air fan **28** for conveying the seed cotton **13** from the seed cotton feeder **27** to some type of rough cleaning stage (i.e., a so-called stick machine **39**) to remove leaves, small trash, sticks, etc. The partially processed seed cotton **13** is then transferred via a slide **40** or the like to one or more gin stands for "ginning", i.e., for separating the cotton fiber or lint from the cotton seed. Each gin stand may include a roller gin or saw gin, etc. A typical cotton gin may have three or more gin stands. After ginning, the cotton fiber is typically referred to as "lint cotton" (sometimes referred to as "cotton lint" or just "lint"). The ginned lint may then pass through a lint cleaning stage to remove additional small trash or dirt remaining in the lint. The cleaned lint is then carried through a lint flue or the like to a battery condenser, where the cleaned lint is formed into a continuous batt and discharged onto a lint slide. The batt is conveyed down the lint slide to a bale press where the batt is compressed and formed into one or more bales. Each bale may then be tied with bailing wire and wrapped with plastic, etc., before being stored or transferred to a warehouse, textile mill, etc.

(17) The seed cotton dryer stage **15** is commonly created by heating the air stream generated by the air fan **28** to form a hot air stream to remove moisture from the seed cotton **13** as the seed cotton **13** is conveyed from the seed cotton feeder **27**. The seed cotton dryer stage **15** may include a gas or oil-fired heater for heating the air to reduce the moisture content of the seed cotton **13**. For example, as diagrammatically shown in

Fig. 2, the seed cotton dryer stage **15** may include a gas supply **29**, such a propane tank or a natural gas supply line, etc., a burner **31** coupled to the gas supply **29** by pipes **33** or the like, and a hot air stream **35** or the like created by the fan **28** and heated by the burner **31** for simultaneously conveying the seed cotton **13** from the seed cotton feeder **27**, and removing moisture from the seed cotton **13** as it is so conveyed. Thus, as illustrated in Fig. 3, the hot air stream **35** flows to the seed cotton feeder **27** where it is mixed with the seed cotton **13** to form a combined seed cotton **13**/hot air stream **35** from the seed cotton feeder **27** to the slide **40** or other parts of a gin stand **17**, etc. The dryer control means **23** of the apparatus **11** preferably includes a gas control valve **36** for controlling the flow of gas from the gas supply **29** to the burner **31** through the pipes **33**, a gas flow meter **37** for measuring the flow of gas from the gas supply **29** to the gas control valve **36** to provide accurate data as a process variable in a PID control algorithm loop controlling the gas control valve **36**, and a heater ignition and safety control **38**. The gas control valve **36** preferably consists of a proportional electrical actuator controlled V port ball valve or the like. The gas flow meter **37** may be a typical gas flow turbine meter well known to those skilled in the art. For example, the gas flow meter **37** may consist of a Sponsler Turbine Meter, Part # ZZ-SPICBPH12 with a Sponsler Loop Powered 4-20ma transmitter, Part # L ZZ-SP712, both manufactured by Sponsler, Inc., a unit of IDEX Corporation, 2363 Sandifer Blvd., Westminster, SC 29693. It should be noted that the cotton gin may include two or more substantially identical seed cotton dryer stages **15** (see Fig. 3) arranged in parallel to or in series with one another, etc., using hot air or the like to remove moisture from the seed cotton **13**.

(18) Measuring the rate of seed cotton **13** entering the seed cotton dryer stage **15** is a critical feature of the present invention. The word "rate" is defined by *Webster's Third*

New International Dictionary, copyright 1976, by G. & C. Merriam Co., as "quantity, amount, or degree of something measured per unit of something else." When used herein in reference to seed cotton **13** entering the seed cotton dryer stage **15**, the word "rate" refers to a quantity or volume of seed cotton per unit of time, eg., pounds or bales of seed cotton per second or minute, etc. The rate measuring means **19** of the present invention preferably measures the "rate" of seed cotton **13** entering the seed cotton dryer stage **15** of the cotton gin in pounds of seed cotton per second. Likewise, when used herein in reference to measuring the rate of seed cotton **13** entering the seed cotton dryer stage **15** and measuring the moisture content of the seed cotton **13** entering the seed cotton dryer stage **15**, the word "entering" is not used to limit or define the physical location of measuring the rate and/or moisture level, but only to mean that wherever the actual measurement is physically taken (e.g., at the seed cotton feeder **27** , in an air stream or conveyor between the seed cotton feeder **27** and the seed cotton dryer stage **15**, at the entrance or exit of the seed cotton dryer stage **15**, within the seed cotton dryer stage **15**, etc.), the actual rate of seed cotton **13** and/or moisture content of the seed cotton **13** entering the seed cotton dryer stage **15** can be accurately determined based on that measurement.

(19) The rate measured by the rate measuring means **19** can be determined by several different mechanisms depending upon which is the most practical for the specific individual ginning system. The actual construction of the rate measuring means **19** may be substantially similar to the rate measuring means "21" disclosed in the cotton moisture restoration apparatus and method of Lewis et al., U.S. Patent 6,389,647, issued May 21, 2002, for measuring the rate of lint cotton exiting the battery condenser of a cotton gin. See, for example, column 3, line 61, through column 4, line 23, of Lewis et al.,

U.S. Patent 6,389,647. Thus, for example, the rate measuring means **19** may include dual potentiometers to replace a typical speed potentiometer on the seed cotton feeder **27**. That is, one of the dual potentiometers will provide seed cotton feed roller speed input signal, and the other of the dual potentiometers, in conjunction with a 10 volt D.C. power supply or the like, will give an analog input (i.e., signal **41** as shown in Fig. 1) to the PLC **25** which can be scaled by the PLC **25** to determine the rate of seed cotton **13** entering the seed cotton dryer stage **15**. On the other hand, the rate measuring means **19** could include a DC/DC transducer connected directly to a speed potentiometer of a feed roller controller of the seed cotton feeder **27** (the controller can be DC or AC invertor), with the output of the transducer (i.e., signal **41** as shown in Fig. 1) connected to the analog input on the PLC **25** so the PLC **25** can scale the analog input to determine the rate of seed cotton **13** entering the seed cotton dryer stage **15** to send the appropriate signal **41** to the PLC **25** via the line **42** (see Fig. 3). Alternatively, the rate measuring means **19** could include a DC sensor (e.g., an inductive proximity switch such as a Censtable AM series M12 DC inductive proximity switch, Model AM1-AN14A) used to count the teeth on a feeder roller shaft of the seed cotton feeder **27**. By sending a DC pulse (i.e., signal **41** as shown in Fig. 1) to the PLC **25** as each tooth passes by the sensor, the rate of seed cotton **13** entering the seed cotton dryer stage **15** can be determined by the PLC **25**. The specific rate measuring means **19** used in a specific gin can be based on many factors, including the structure and operation of the gin itself, the desires of gin management, etc.

(20) The moisture content measured by the moisture content measuring means **21** can be determined by several different mechanisms depending upon which is the most practical for the specific individual ginning system. The actual construction of the

moisture content measuring means **21** may be substantially similar to the moisture content measuring means "25" disclosed in the cotton moisture restoration apparatus and method of Lewis et al., U.S. Patent 6,389,647, issued May 21, 2002, for measuring the rate of lint cotton exiting the battery condenser of a cotton gin. See, for example, column 3, lines 45-55, of Lewis et al., U.S. Patent 6,389,647. Thus, for example, the moisture content measuring means **21** preferably consists of a Moisture Register Products BSP 901-1 Mod-115 Moisture Measuring System radio frequency sensor marketed by Moisture Register Products, a division of Aqua Measure Instrument Co., 1712 Earhart Court, La Verne, CA 91750-0369. Such a moisture content measuring means **21** may have a sensor located within the seed cotton feeder **27** as shown diagrammatically in Fig. 3, and electrically coupled to the PLC **25** via a line **43** (see Fig. 3), for sending a signal **45** to the PLC **25** (see Fig. 1) which can be scaled by the PLC **25** to determine the moisture content of the seed cotton **13** entering the seed cotton dryer stage **15**.

(21) The apparatus **11** may include an ambient temperature sensor **47** for measuring the ambient or room temperature within the cotton gin. The ambient temperature sensor **47** may be of various types known to those skilled in the art. Thus, for example, the ambient temperature sensor **47** may consist of a Pyromation Type J thermocouple, part # J39G-006-00-6HN31, marketed by Pyromation, Inc., 5211 Industrial Road, Fort Wayne, IN 46825. Such an ambient temperature sensor **47** may have a sensor located at a centralized location within the cotton gin, and electrically coupled to the PLC **25** via a line **49** (see Fig. 3), for sending a signal **51** to the PLC **25** (see Fig. 1) which can be scaled by the PLC **25** to determine the ambient or room temperature within the cotton gin, etc.

(22) The apparatus **11** may include desired moisture level control **53** for allowing gin management to enter the desired moisture level of the seed cotton **13** leaving the seed cotton dryer stage **15**. The desired moisture level control **53** may be of various types known to those skilled in the art. Thus, for example, the desired moisture level control **53** may consist of an Automationdirect Operator Interface, Part # EZ-S8C-F, marketed by Automationdirect.com, 3505 Hutchinson Road, Cumming, GA 30040. Such a desired moisture level control **53** may have a control panel located at a centralized location within the cotton gin, and may be electrically coupled to the PLC **25** via a line **55** (see Fig. 3), for sending a signal **57** to the PLC **25** (see Fig. 1) which can be scaled by the PLC **25** to determine the desired moisture level of the seed cotton **13** leaving the seed cotton dryer stage **15**.

(23) The PLC **25** is preferably controlled by the program disclosed in Figs. 4A-4I, taken together and arranged as shown in Fig. 4, using a signal **41** from the rate measuring means **19** (e.g., analog outputs from potentiometers, transducers or sensors as hereinabove disclosed relative to the several possible embodiments of the rate measuring means **19**) as inputs to ginning rates V2120 in the program to calculate the rate of seed cotton **13** entering the seed cotton dryer stage **15**. An analog output or signal **45** from the moisture content measuring means **21** as determined from the seed cotton **13** entering the seed cotton dryer stage **15** is used in the program as incoming moisture sensor V2102 . An analog output or signal **51** from the ambient temperature sensor **47** is used in the program as ambient temperature sensor V2140. An analog output or signal **57** from the desired moisture level control **53** is used in the program as desired moisture level V2402. The gas flow meter **37** calculates the flow of gas through the supply pipe **33** to the gas control valve **36**, and sends the appropriate signal **59** to the PLC **25** (see

Figs. 1 and 2) via the line **61** (see Fig. 3). The program then calculates and determines when and how much gas needs to pass from the gas supply **29** to the burner **31** to dry the seed cotton **13** passing through the seed cotton dryer stage **15**, and sends the appropriate signals **63** to the gas control valve **36** (see Figs. 1 and 2) via the line **65** (see Fig. 3).

(24) The preferred method of the present invention includes the steps of measuring the incoming moisture content of the seed cotton **13** entering the seed cotton dryer stage **15** using, for example, the moisture content measuring means **21**; measuring the rate of seed cotton **13** entering the seed cotton dryer stage **15** using, for example, the rate measuring means **19**; and then removing an amount of moisture from the seed cotton **13** in the seed cotton dryer stage **15** based on the desired moisture content of the seed cotton **13** leaving the seed cotton dryer stage **15**, the moisture content of the seed cotton **13** entering the seed cotton dryer stage **15**, and the rate of seed cotton **13** entering the seed cotton dryer stage **15**. The gas flow rate needed to remove that desired amount of moisture, depending on the efficiency of the specific seed cotton dryer stage **15**, the rate and moisture content of the seed cotton **13** entering the seed cotton dryer stage **15**, etc., is computed by the PLC **25**. The actual gal flow rate is measured by the gas flow meter **37**, and the gas control valve **36** is then adjusted based on that data.

(25) As thus constructed and used, the present invention can automatically remove a desired amount moisture from the seed cotton **13** passing through the seed cotton dryer stage **15**, to deliver a very accurate moisture regardless of the incoming moisture or the rate of the seed cotton.

(26) Although the present invention has been described and illustrated with respect to a preferred embodiment and a preferred use therefor, it is not to be so limited since

modifications and changes can be made therein which are within the full intended scope of the invention.